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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

# FOREST INSECT CONDITIONS IN THE YELLOWSTONE NATIONAL PARK DURING THE SEASON OF 1927

By

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and
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U. S. Department of Agriculture.

Stanford University, California
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# FOREST INSECT CONDITIONS IN THE YELLOWSTONE NATIONAL PARK DURING SEASON OF 1927

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# FOREST INSECT CONDITIONS IN THE YELLOWSTONE NATIONAL PARK DURING THE SEASON OF 1927.[1]

By

H. E. Burke, Entomologist
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SUMMARY

1. Forest insect conditions in the Yellowstone National Park during 1927 were about the same as in 1926.

2. A new pest, the spruce gall aphid, created considerable alarm early in the season because it caused the needles on many of the Douglas fir along the Madison and Gallatin Rivers to turn brown and fall. The new growth came out in good condition, however, and according to present indications there will be little permanent damage.

3. Spraying to control the needletyer and sawfly infestations in the lodgepole pine along the West Yellowstone Madison River highway was conducted as in 1924, 1925, and 1926. As a result of this spraying the trees along the highway were protected from defoliation for the year 1927. This protection is only temporary, however, because the area becomes reinfested from uncontrolled adjacent infested areas in the Madison Basin.

4. Treating the barkbeetle infested lodgepole pine around

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1. See Evenden, J.C. Defoliation of Timber Stands within the Yellowstone National Park, October 5, 1923.
Forest Insect Problems of the Yellowstone National Park, October 22, 1924.

Burke, H. E. Forest Insect Conditions in the Yellowstone National Park During the Season of 1925, March 16, 1926.
Forest Insect Conditions in the Yellowstone National Park During the Season of 1926, February 1, 1927.

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the camp sites and geyser formation areas, by felling and burning, was very successful. Reductions in infestation from 50% to 100% were obtained. The average for the seven areas in which the infested trees were treated was 83%.

5. Owing to a misunderstanding only part of the beetle infested Douglas fir at Camp Roosevelt were treated during the winter of 1926-27. The infestation increased from 21 trees infested in 1926, to 85 infested in 1927.

6. The Douglas fir beetle infestation which developed in the budworm defoliated areas along the Yellowstone River between Crevice Gulch and Garnet Hill, has spread up Little Buffalo Creek, Hellroaring Creek, Hellroaring Mt., Cottonwood Creek, Cottonwood Mt., Garnet Hill and Crescent Hill until there are thousands of dead trees. Examinations of infested trees indicate that the worst is over, and that there probably will be considerable reduction in the infestation this year.

7. Conditions found in 1927 indicate that the Yellowstone will need $4,000. for forest insect control work in 1928; $3,000. for spraying against the needletyer and sawfly, and $1,000. for treating barkbeetle infested trees.

## INTRODUCTION

The writers spent part of the field season of 1927 in the Yellowstone National Park investigating insect injuries to forest trees. Edmonston was in the Park from June 5th to July 10th, and again from August 9th to September 8th. Burke was there from June 30th to July 10th, and again from August 9th to 21st. Headquarters were established at the Riverside Ranger Station near West Yellowstone, Montana. Trips were made to all of the "loop" stations, the northern, eastern, southern, and Gallatin entrances, and outside of the Park to the Wapiti Ranger Station on the Cody Road, to Targhee Pass on the West Yellowstone Highway, and to Gallatin Gateway on the Bozeman Highway.

All of the work was conducted in close cooperation with the National Park Service and the Forest Service. As in the past, the Park officials and the Forest Service officials assisted in numerous ways during the season.

## GENERAL CONDITIONS FOUND

Forest insect conditions in the Yellowstone in 1927 were about the same as in 1926. The spruce budworm appeared in epidemic form outside of the Park on the Cody Road but no infestation was found inside the Park. The lodgepole needletyer occurred in about the same numbers as last year. There was a slight increase in the number of the lodgepole sawfly. A new pest of the Douglas fir, the spruce gall aphid (Chermes cooleyi Gill), created considerable alarm early in the season, but apparently no permanent damage was caused by the work. The barkbeetle infestation in the Douglas fir around the budworm areas increased, while that in the lodgepole pine around the camp sites and formation areas decreased.

### Defoliators.

The lodgepole sawfly, Neodiprion sp., increased slightly in numbers at West Yellowstone over 1926. A few eggs were laid but none of these hatched and no caterpillars were seen. The needletyer, Eulia sp., moths appeared in considerable numbers and numerous eggs were laid. These hatched into caterpillars and considerable defoliation occurred especially in the Madison National Forest a few miles west of the Park boundary.

The spruce budworm, Cocoecia fumiferana (Clem). did not appear within the Park boundaries but it was found in an epidemic form a few miles outside of the Eastern Entrance along the Cody Road in the Shoshone National Forest. Considerable timber has been killed in the past and the resort owners in the Forest are much alarmed.

### Sucking Insects.

The spruce gall aphid, Chermes cooleyi Gill., appeared in the Yellowstone in numbers for the first time. Many Douglas fir along the Madison River between the Guaging Station and Madison Junction, and along the Gallatin River between Karst Kamp and the Wyoming line appeared brown and thin foliaged by the last of June. The 1927 foliage came out almost normally, however, and by the end of August most of the trees appeared in good condition. A very few may succumb. The pine leaf scale, Chionaspis pinifoliae Fitch, was found in numbers on the needles of some small whitebark pine along the Madison River near West Yellowstone.

Barkbeetles.

The Douglas fir beetle, Dendroctonus pseudotsugae Hopk., has continued to kill numerous Douglas fir in the budworm defoliated areas along the lower Yellowstone Valley. Thousands of red, dying trees occurred north of the Yellowstone River on the sides of Hellroaring Mountain and on the hill between Cottonwood Creek and Crevice Gulch. Many others were found at the bases of Crescent Hill and Garnet Hill. One large infested tree was found at the lower Tower Falls Camp and groups of infested trees back of Camp Roosevelt and on the slopes of the hill north of the Petrified Tree. Small groups of red trees were seen near Blacktail Deer Creek and near Undine Falls.

The mountain pine beetle, D. monticolae Hopk., was not found in injurious numbers in the Yellowstone during 1927. The Dunraven Pass infestation appears to have been brought under complete control and only a few trees were seen in the Sylvan Pass Area. Some infestation was found near the Eastern Entrance at Pahaska Lodge but the infesting broods were in poor condition, and the infestation appeared to be waning.

The Engelmann spruce beetle, D. engelmanni Hopk., was not found in numbers during 1927. The Cub Creek infestation appears to have died out. One large tree near Camp Roosevelt was found with a brood of this species under the bark at the base. Apparently, however, the beetles were not the cause of the death of the tree.

The lodgepole pine beetle, D. murrayanae Hopk., was scarce during 1927. A few specimens were trapped in recently felled trees, but no attacks were found on living trees.

The Oregon engraver beetle Ips oregoni (Eich), occurred in reduced numbers. A few infested trees were found at West Yellowstone and in most of the camp grounds, but the control work conducted during 1925 and 1926 in the camp grounds appears to have resulted in considerable reduction in the annual loss.

The fir beetle, Dryocoetes confusus Sw., did not occur in sufficient numbers to be of any great importance in 1927. The infestations at Cub Creek and in the Sylvan Pass country appear to be dying out.

Bark weevils.

The lodgepole pine barkweevil, Pissodes murrayanae Hopk., occurred in considerable numbers at West Yellowstone, but apparently attacked only injured trees this season.

The alpine fir barkweevil, P. burkei Hopk., was scarce. No attacks were found on living trees.

The lesser lodgepole pine barkweevil, Cylindrocopturus sp., was common on the trunks of small injured trees. Under certain conditions it undoubtedly assists the lodgepole pine barkweevil to kill numerous small trees.

Barkborers.

The western hemlock flatheaded barkborer, Melanophila drummondi Kirby, appears to be one of the species involved in the killing of numerous Douglas fir in the public camp grounds at Mammoth. Most of the trees appear in poor condition but they might eventually regain their vigor if it were not for the attack of several species of borers.

The western fir roundheaded barkborer, Semanotus nicolas White, is a second species involved in the killing of the Douglas fir at Mammoth. Numerous specimens were taken from under the bark of dying trees in the camp grounds.

## THE LODGEPOLE NEEDLETYER AND THE LODGEPOLE SAWFLY

Amount of Damage Caused.

There was considerable needletyer infestation in the Madison Basin during 1927, but very few trees were killed. As in 1926 the areas most affected by the defoliations were in townships 13 S, R 44 and 45 E, two to five miles west of the National Park boundary in the Madison National Forest. Considerable defoliation was found in the Park along the West Yellowstone - Madison Junction highway between West Yellowstone and the Madison Gauging Station.

A few more sawflies were found than in 1926, but none of the eggs found hatched and no defoliation by this species was found. Practically all of the cocoons of the 1924 generation have now produced their sawflies and this species probably is reduced to its lowest numbers, and should give no trouble for years.

Life History of Needletyer during 1927.[2]

By June 20th a few moths had emerged from the chrysalids and laid eggs. By June 28th, most of the moths had emerged and a few eggs had hatched. By July 10th most of the eggs had hatched and the young caterpillars were working in the needles. Some unhatched eggs could still be found, however. August 16th, most of the caterpillars were about half grown and in tubes formed of the new needles. The tips of the tubes were turning yellow but the work was hardly noticable. September 5th, most of the caterpillars were well grown but still in tubes on the trees. A few were found on the ground. No chrysalids were found on that date. By September 15th, practically all of the caterpillars were on the ground and had formed their chrysalids.

Thirty-six chrysalids collected by Ranger Arthur Jacobson March 3rd and sent to the Palo Alto laboratory, produced 17 moths between March 17th and 21st. All of these died without laying eggs.

Twenty-five groups of eggs studied contained an average of 9½ eggs to the group. The maximum was 23 and the minimum, 3. Practically all of the eggs collected (fresh) hatched on the seventh day after collection. A few held over to the tenth day after collection.

Life History of Sawfly.

In the Palo Alto Laboratory from January 5th - 12th, two males emerged from cocoons collected at West Yellowstone on August 9, 1926. Both died a few days later. On June 22 and 23 at West Yellowstone several males and 1 female sawfly were found on the lodgepole foliage. Between June 22 and July 5th, eleven needles containing eggs were found. These averaged five eggs to the needle. The maximum was eight and the minimum 1. All of the needles except one contained an incompleted egg pocket as well as those containing the eggs. In eight cases the group started with the incompleted pocket. In one case two eggs were laid, the incompleted pocket was formed and two more eggs laid and in the third case one egg was laid and then the incomplete pocket was formed and the needle abandoned.

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2. For a full account of life history see report for 1926.

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Control Work.

Spraying to prevent defoliation of the lodgepole pine along the highway between West Yellowstone and the Madison River bridge was conducted as in 1924, 1925, and 1926. A strip of timber from 150 to 200 feet on either side of the highway was sprayed with the arsenate of lead, fish oil formula. The control work was very successful, there being a noticable difference in the number of caterpillar-infested tubes on the sprayed and the unsprayed trees.

## THE SPRUCE BUDWORM

Although no budworm infestation is found in the Yellowstone at the present time a very active infestation is working toward the Park along the Cody Road from the East. On July 7th, the area between June Creek and Pahaska Lodge was examined with Supervisor Longworthy and Ranger Spencer of the Shoshone National Forest.

Many of the Douglas fir in the June Creek area have been killed. The trees around the Blackwater Resort were heavily infested, nearly full-grown caterpillars hanging on long webs from the trees everywhere. Most of the buds were severely injured but the old foliage looked very good. Further back in the forest the foliage is very thin and some of the trees have been killed by subsequent attacks of the Douglas fir beetle.

The caterpillars were working on alpine fir, Engelmann spruce, lodgepole pine, limber pine and western juniper as well as the Douglas fir. Apparently the caterpillars did not attack the pines and the juniper until they had fed for a time on the Douglas fir. The attack on the alpine fir and the Engelmann appeared to be primary. So far as could be determined, however, the insect does not appear in any areas except where some Douglas fir occurs.

A few caterpillars were found on Douglas fir at Holm Lodge and on alpine fir at Pahaska.

The infestation near June Creek is supposed to be at least five years old.

## THE SPRUCE GALL APHID

This species which occurs in practically all of the Rocky Mountain and Pacific Coast states seldom causes any

noticable damage to forest trees. This year, however, practically all of the Douglas fir in the upper Gallatin Valley between Karst Kamp and the Wyoming line turned brown by the first of June and looked as if they were going to die. Many of the Douglas fir along the Madison River between the Guaging Station and the Madison Junction were effected in the same way. Later the brown old needles fell from the trees, the new ones came out in good condition, and the trees appeared to have recovered without any serious damage.

The aphid, which appears to be the cause of the trouble, is a small dark sucking insect which spends the winter resting upon the upper surface of a needle. In the spring as soon as the weather becomes warm it starts to grow, sheds its skin and throws out a protective covering of long curled threads of a white secretion which resembles wool. About the first of May, twenty-five to forty light yellow eggs are laid under the wooly covering. These hatch when the new growth of the tree starts and the young crawlers move out on the new needles, insert their beaks into the tender growth and begin to feed and grow. It is the sucking of the sap in feeding that injures the needle, and if the insects are sufficiently numerous, causes it to turn brown, die and finally fall from the tree.

When the aphids become full grown, they lay eggs like their parents. These soon hatch and the young insert their beaks into the needles, take on a dark color, secrete a little "wool" about themselves, and so remain until the following spring before growing and becoming adult.

Certain individuals of the spring generation develop wings and fly away to the Engelmann spruce where they lay their eggs on the needles. The young hatching from these crawl to the developing buds of the spruce and settle at the bases of the young needles and feed. This feeding causes an abnormal growth of the bud which forms a cone-like gall. This gall gives the insect its name of the spruce gall aphid.

Control consists of spraying the infested trees in the early spring with a solution of five gallons of miscible oil, 1 quart of 40% nicotine sulphate to 200 gallons of water.

## THE PINE LEAF SCALE

This conspicuous small, oyster shell-like, white scale occurs on the needles of coniferous trees throughout the United States. Each scale is about 1/8 of an inch long and has a yellowish tip. Sometimes the foliage is almost completely white from the numerous scales which cover the surface of the needles.

In only one case was the insect found in sufficient numbers to do any damage to trees in the Yellowstone. This was an infestation of small whitebark pine along the Madison River near the Riverside Ranger Station. In this case the insects were in sufficient numbers to cause a yellowing of the foliage.

The white objects seen are the scales of the mature females. The winter is passed as an egg beneath this scale. The egg hatches in the spring. The young crawls about over the foliage for a day or two, comes to rest on a needle of the new growth, inserts its beak and starts to feed by sucking out the sap from the needle. In about three weeks the adult stage is reached and 20 to 30 purplish eggs are laid under the scale. These soon hatch and produce the parent scales that lay the eggs which carry over the winter.

Spraying the foliage of infested trees with miscible oil solution when the young crawlers are hatching in the spring will control the pest.

## THE DOUGLAS FIR BEETLE.

The Douglas fir beetle continued to kill numerous trees on the budworm defoliated areas. The south side of Hellroaring Mountain from the Yellowstone River at the bottom to the lodgepole forests at the top is red from the foliage of dying trees. Trees are dying around Crescent Hill, at the base of Garnet Hill, up Little Buffalo Creek and on the hill side between Cottonwood Creek and Crevice Gulch.

Supervisor Martin of the Absaroka Forest reports this insect to be killing trees at the head of Hellroaring Creek and near Jardine, just north of the Yellowstone Park.

The beetle is also killing some trees outside of the budworm areas. Small groups of infested and dying trees were found back of Camp Roosevelt, near the Petrified Tree, on the flat between Oxbow and Blacktail Deer Creek, and on the hillside below the road between Undine Falls and the Gardiner River Bridge. A single large infested tree was found in the lower camp at Tower Falls.

The Douglas fir beetle is also present in the Shoshone Forest along the Cody Road between the Eastern Entrance and the Wapiti Ranger Station. Patches of dead trees are scattered along both sides of the river. Only a few red and yellow trees are seen. Numerous dead trees in the budworm areas up Blackwater Creek showed the characteristic beetle work under the bark of the main trunk.

The infested area back of Camp Roosevelt now contains 85 trees which should be felled and barked before April 1, 1928. Thirty-seven of these contain active broods of the Douglas fir beetle and 48 contain partial broods. All should be treated to prevent any chance of destructive insects breeding up in them and attacking the remaining living trees.

The infested trees on the hill near the Petrified Tree should be treated at the same time as those at Camp Roosevelt.

## THE MOUNTAIN PINE BEETLE.

No noticable damage to the forests of the Yellowstone by the mountain pine beetle was observed in 1927. The infestation at Dunraven Pass and in the Sylvan Pass area appear to have died out, or to have been brought under control.

Numerous red and dead lodgepole were found outside of the east boundary of the Park at Pahaska Lodge in the Shoshone National Forest when that area was visited on July 7 with Supervisor Longworthy and Ranger Spencer. The infested trees occurred in groups of from four to ten. Most of the infesting broods were dead which indicates that the infestation is dying out.

The experiment of cutting infested lodgepole during the winter and allowing it to season with the hope that the infesting broods would die was not successful. The broods in the felled trees appeared to be in better condition than those in the standing trees.

Ranger Arthur Jacobson of the Madison National Forest reported an infestation of this beetle north of Targhee Pass at an elevation of 8,500 feet. Groups of red, dying and green infested whitebark pine were found on September 20th.

## THE ENGELMANN SPRUCE BEETLE.

This species also appeared to be quiet during 1927. A few beetles were found crawling over a log pile at Cub Creek on July 6th, but no freshly infested trees were observed. The

Grayling Creek infestation appears to have stopped. One large Engelmann spruce, three feet in diameter was found at Camp Roosevelt on August 14th, which was shedding its needles. There were a few mines of the beetle under the bark of the base. The brood was in the large larval stage. The infestation did not appear heavy enough to have killed the tree, but no other reason for its death could be found.

## THE OREGON ENGRAVER BEETLE.

The Oregon engraver beetle occurred in reduced numbers in the Yellowstone during 1927. A few infested trees were found at West Yellowstone, a few in the needletyer defoliated areas north of the Madison River, and a few in the various camp grounds and on the geyser formation areas.

The control work conducted during 1925 and 1926 appears to have benefited the camp ground and formation areas considerably. The Lake Camp which had 23 infested trees in 1925 and 10 in 1926 had no infested trees in 1927. The Fishing Bridge Camp with 47 in 1925, and 10 in 1926, had 4 in 1927. Even the Mud Volcanoes area with 500 trees treated in 1925 and 150 in 1926 only had 27 infested standing trees and about 12 infested windfalls in 1927.

All of the observations made indicate that there are two generations of the Oregon engraver beetle in the Yellowstone. A large tree near West Yellowstone attacked on June 22nd, produced a brood of beetles which emerged by August 15. A tree at the Madison Bridge contained a brood of young beetles which were emerging on August 16. A tree at the Fishing Bridge Camp contained a brood of pupae and beetles about ready to emerge on August 18th.

Associated with the Oregon engraver beetle, usually one found the secondary barkbeetles, Ips radiatae, Hopk., Ips latidens Lec., Orthotomicus caelatus Eich., Pityogenes knechteli Sw., and sometimes at the base of the tree, Hylurgops rugipennis Mann.

## THE LODGEPOLE PINE BARKWEEVIL

The work of the lodgepole weevil was not so evident in 1927 as in 1926. Very few small trees were killed. Several small trees with mistletoe scars on their trunks and with yellowing foliage were examined on June 29th. The branches growing off of the trunk below the girdling scar were green and the bark at the base was green.

Adults of the weevil were crawling around the bases of the trees and some eggs were found in the inner bark of one tree. These were laid in small cavities in the inner bark excavated by the female beetle. One or two eggs were found in each cavity.

Numerous live beetles were caught resting on a pile of lodgepole wood on July 1st.

Beetles placed in jars containing fresh lodgepole twigs fed on the new needles. Most of the feeding was done at the bases of the new needles by puncturing the sheaths with the beak.

According to the observations made in 1926 and 1927, the life cycle of this species is as follows: The beetles emerge from the dying trees during the last half of September and the first of October, feed on the foliage of the live trees, hibernate over the winter in the old needles and other debris at the base of the trees, come out of hibernation about the first of June, feed on the new needles, mate and lay eggs in the bark of injured or dying trees, in June. The grubs soon hatch from the eggs, feed in the cambium of the lower trunk of the tree until they become full grown about the last of August. Pupation then takes place in a chip cocoon excavated in the outer wood. The pupa soon transforms to an adult which is ready to emerge by the middle of September.

Control consists of burning the infested trees before the middle of September.

## THE LARGER LODGEPOLE PINE BARK WEEVIL.

During the last of June and the first of July 1927, the small dark gray weevils of this species were common on the bark of the trunks of small trees felled or girdled for traps at West Yellowstone. They were also found on trees with the tops dying from mistletoe girdling. In practically all cases they were found in the same trees with the lodgepole weevil. They have been found in the tops of larger trees where they were associated with the engraver beetles.

Infested wood taken into the laboratory in 1926 produced beetles all through the winter from October 13th to April 26th. It is not believed, however, that the beetles emerge before spring in the Yellowstone. According to the observations made in 1926 and 1927, the eggs are laid during the last of June and the first of July, the larvae feed in the inner bark and outer wood until they become full grown about the middle of August, when they form cylindrical pupal cells in the outer wood. They rest in the pupal cells most of the winter, pupating and transforming to weevils in the spring just before they emerge.

In 1926 the lesser weevil undoubtedly assisted the lodgepole weevil to kill a number of small lodgepole in the vicinity of West Yellowstone. These trees appeared to be in fair condition, but they had been defoliated or partially defoliated by the needle-tyer in 1924 and 1925.

The control of the barkweevil would result in the control of this species.

THE WESTERN HEMLOCK FLATHEADED BARKBORER

The western hemlock flatheaded bark borer is a white tadpole-like grub from ¼ to ½ of an inch long. It mines the inner bark of normal, injured and recently felled fir, Douglas fir, hemlock and spruce. Pupation and the transformation to the beetle takes place in the spring in a cell in the bark or in the outer wood. The beetle which is brownish bronze, often with two to six yellow spots, emerges from the pupal cell through a crescent shaped emergence hole. Emergence takes place from May to early July, and the eggs are laid soon afterward under the scales of the bark.

This barkborer has been reported as killing many trees in various areas in the Rocky Mountains and Pacific states; usually, however, it prefers to attack weakened trees.

Many of the trees in the camp ground at Mammoth appear to be in poor condition. Some of the Douglas fir contained broods of this borer under the bark. The observations, however, indicated that something was wrong with the trees before they were attacked by the borers. The death of the trees was hastened by the attack but the borers do not appear to be the primary cause.

Felling and burning the infested trees before May 1st should control this insect.

THE WESTERN FIR ROUND-HEADED BARKBORER

Associated with the flatheaded barkborer in the dying Douglas fir at Mammoth is a more cylindrical, heavier, round-headed borer of about the same length. This is the grub of a blackish or bluish black beetle about ½ an inch long, and with two bars of reddish-brown across the wing covers. The "horns" are about the same length as the body and there is more or less light hair, especially on the legs and the undersides of the body.

The eggs are laid in crevices in the bark during spring and summer. The grubs excavate winding mines through the inner bark and outer wood. Pupation and the transformation to the beetle takes place in a cell in the bark or in the outer wood. Emergence is through a circular hole gnawed in the bark. The species winters over in the bark or outer wood as a grub, pupa or beetle. Emergence may occur from March to September.

The round-headed borer like the flat-headed borer has been reported to kill trees in various parts of the west. It attacks the fir, Douglas fir, hemlock, spruce and probably pine. The trees at Mammoth appear to be in poor condition and the attack of the borer probably is secondary.

Control consists in felling and burning infested trees before May 1st.

## DYING TREES AROUND GEYSER FORMATIONS AND IN CAMP GROUNDS

During the season of 1927 insects continued to cause the death of numerous trees around the geyser formations and in the various camp grounds. The control work conducted in 1925 and 1926 brought substantial reductions in the infestations. The following conditions were found on an examination made August 14th to 16th.

Old Faithful Public Camp. Fourteen red-top lodgepole infested with Oregon engraver beetle. Thirty in 1926.

Thumb Public Camp. Thirty-one red and yellow top lodgepole infested with Oregon engraver beetle. Thirty-five in 1926, 72 in 1925.

Lake Public Camp. Two red-top lodgepole, 8 in 1926, 23 in 1925.

Lake Lodge. No infested trees. 10 in 1926, 23 in 1925.

Fishing Bridge Camp. Four lodgepole infested with Oregon engraver beetle. Ten infested in 1926, 47 in 1925.

Mud Volcanoes. Thirty-nine infested standing and wind felled lodgepole. 150 infested in 1926, 500 in 1925.

Dunraven Pass. No white bark pine infested with mountain pine beetle. 4 in 1926, 25 in 1925.

Tower Falls Lower Camp. One large Douglas fir infested with Douglas fir beetle. 1 in 1926, 0 in 1925. The 1926 infested tree was treated.

Camp Roosevelt. Eighty-five Douglas fir infested with Douglas fir beetle, 21 infested in 1926, none in 1925. Five of the 1926 infested trees were treated by the caretaker at Camp Roosevelt. The remainder was left untreated.

Mammoth Camp. Numerous trees in this camp are in poor condition. Flathead and roundhead borers are working under the bark of some that are dying.

Roaring Mountain. No infestation observed. None in 1926, 150 lodgepole infested with engraver beetle treated in 1925.

## CONTROL PROBLEMS

There are three forest insect control problems in the Yellowstone which have drawn most of the attention during the past four years.

1. First is the spraying of the lodgepole pine in the vicinity of West Yellowstone to control the defoliation caused by the needletyer and the sawfly. The trees for 150 to 200 feet on either side of the main highway between the western entrance at West Yellowstone and the Madison River Gauging Station, a distance of about five miles, were sprayed during 1924, 1925, 1926, and 1927. In 1925-1927, the spraying was continued to the Madison River Bridge, a distance of a little over seven miles. Besides the spraying along the main highway, 3 - 4 miles of lateral highway between West Yellowstone and the Riverside Ranger Station were sprayed.

This spraying has resulted in preventing the defoliation of the trees along the highway, while the trees on outside areas have been completely defoliated, and those on some 12,000 acres in the Madison Basin have been killed.

Since the defoliation on the outside areas is not controlled, the moths from these areas fly into the controlled areas each spring and reinfest them. This is why it is necessary to spray the same areas year after year.

There is no question that continued spraying of the highway trees will keep them from becoming seriously defoliated. At the same time one can not help but believe that it would pay to dust the entire infested area in the Madison Basin for one year, by use of an aeroplane, and stop the infestation once for all. This would not only remove the menace of reinfestation of the highway trees in the Park but would prevent the dying of considerable timber in the Park and in the adjacent Madison National Forest.

2. The second Yellowstone control problem is that of preventing the attacks of secondary barkbeetles on trees around the camp sites and geyser formation areas.

During 1925 and 1926 the infested trees around many of the camps and the geysers formations on the main loop have been treated by felling and burning.

This has resulted in a great decrease in the number of dying trees. However, as long as new building takes place and trees are injured by camping and hot water outflows, there will be a concentration of insects from the surrounding forests to these places and the continued dying of some trees.

Just as with the spraying at West Yellowstone, this means that control work will have to be carried year after year.

3. The third major control problem in the Yellowstone is that of the Douglas fir beetle in Douglas fir in the vicinity of Camp Roosevelt. Upon recommendation by Evenden the first control work in this area was conducted in May, 1924. Some reinfestation was treated in the fall of 1924. During 1925, the area was very clean, no infested trees being found. In the summer of 1926 a new infestation of 21 trees was found directly back of the Camp. Through a misunderstanding only a few of these trees were treated during the winter of 1926 - 27. In August 1927, there was an infestation of 85 trees.

The results of the control work conducted in May, 1924, indicate that the control recommended for this species is successful. The discouraging feature in this case is the liability of reinfestation from the large infested areas at Crescent Hill and along the Yellowstone River below Garnet Hill, where control appears to be impracticable.

## RECOMMENDATIONS

It is recommended that the following operations be conducted by the Park Service during the fall of 1927 and the spring of 1928.

1. The trees for 150 feet on either side of the highway between West Yellowstone and the Madison River bridge be sprayed in June 1928. Cost $3,000.00.

2. The infested Douglas fir at Tower Falls, Camp Roosevelt, and the Petrified Tree be felled and barked or burned before April 1, 1928. Cost $600.00.

3. The infested lodgepole at Old Faithful, Thumb, Lake, Fishing Bridge and Mud Volcanoes be felled and barked or burned before June 1, 1928. Cost $250.00.

4. The dying trees at Mammoth Camp be cut and barked or burned before June 1, 1928. Cost . 150.00.

5. The budworm infestation on the Cody Road just outside the Eastern Entrance be watched closely for developments. It appears to be working toward the Park, and undoubtedly would kill considerable timber unless controlled.

Stanford University, California
January 7, 1928.

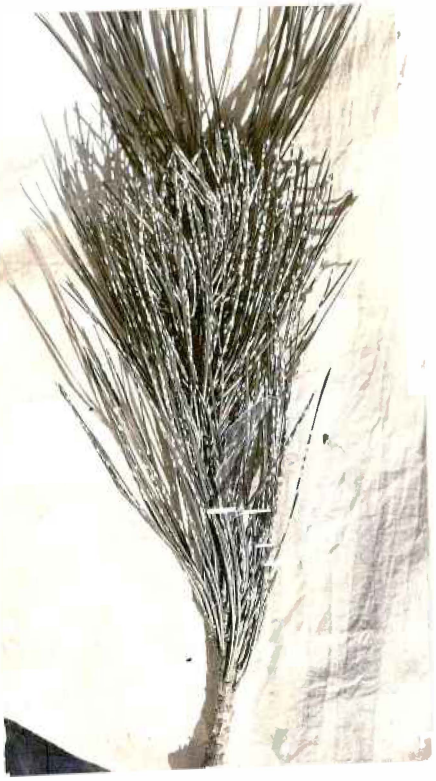
A. - Spruce gall aphid (Chermes cooleyi Gill.) on needles of young Douglas fir.

B. - Pine leaf scale (Chionaspis pinifoliae Fitch) on needles of pine.

C. - Needletyer (Eulia sp.) moths on needles of pine.

Photographs by H. E. Burke, F. P. Keen and J. M. Patterson.

A.



B.

C.